2003 CONSOLIDATED MONITORING REPORT
NARRATIVE SUMMARY
March 2004

The attached tables and figures present the data collected in 2004 for Implementation and Functional monitoring of restored areas at the Fernald Closure Project (FCP). Implementation monitoring included vegetation survival and herbaceous cover estimates within the Area 2, Phase I (A2PI) Southern Waste Units (SWU) Restoration Project and photographic documentation of the A1PI Wetland Mitigation Project. Data from these efforts are presented in Tables 2, 3, 3a through 3d, and Figures 1 and 2. Functional monitoring involved comparisons of restored emergent wetland communities in A1PI, A8PII, and A2PIII to baseline conditions and reference sites. These data are presented in Tables 4 and 4a through 4c. Precipitation data for 2003 is presented in Table 1.

Vegetation survival in the SWU is presented in Table 2. Two separate percent survival values are calculated, with resprouts and trees with less than 50 percent canopy counted as both alive and dead. Most of the dead and unaccounted for plants are attributed to deer browsing. Fencing of shrub patches proved very effective. Shrub survival within fenced patches was well over 90 percent, with very few dead plants. On the other hand, shrubs that were not fenced experienced high rates of mortality. The use of fencing around shrubs will be expanded for future restoration projects.

Herbaceous cover estimates for the SWU are presented in Table 3. Seeded areas were divided into four categories; slope stabilization/erosion control areas, wetland areas, mesic areas, and xeric areas. The distribution of these areas is presented in Figure 1. Area-specific species lists are provided in Tables 3a through 3d. Native vegetation is becoming successfully established across the SWU, with native species composition and relative frequency greater than 50 percent in all areas. Cover estimates demonstrate that only the slope stabilization/erosion control areas came close to meeting the 90 percent cover requirement. This is probably due to the fact that seeding rates were doubled and jute and/or coir matting was used on seeded slopes. DOE expects that cover in other areas will increase as native vegetation grows in the next couple years.

Figure 2 shows the progress of vegetation across the A1PI Wetland Mitigation project over four years of growth. In general, the photographs demonstrate that native vegetation has successfully established across the project. Herbaceous and woody vegetation is growing and spreading. Cattails (*Typha sp.*) appear to dominate some areas. DOE will continue management activities within the mitigation project to maintain native plant diversity.

The Functional monitoring data summary is presented in Table 4. Area-specific species lists are found in Tables 4a through 4c. A comparison of all survey parameters demonstrates that restored wetlands at the FCP are providing extensive ecological benefit. All native species and conservatism measurements are considerably better than baseline conditions. The average Coefficient of Conservatism (CC) and Floristic Quality Assessment Index (FQAI) for the A8PII Forest Demonstration Project were almost as high as the emergent wetland reference site. The Radium Hot Spot CC and FQAI values were not quite as high, but its relative frequency of native vegetation was very similar to the reference site. In summary, restored wetlands at the FCP are meeting the goal of establishing pre-settlement native communities.

Implementation monitoring activities in 2004 will include a delineation of wetland acreage in A1PI and vegetation survival and herbaceous cover estimates in the Northern Pines. Herbaceous cover within Subareas 1 and 2 of the Borrow Area will also be evaluated. Functional monitoring will focus on restored prairies and savannas in A8PI and A8PII. Maintenance of restored areas will also continue in 2004.

2002 CONSOLIDATED MONITORING REPORT FOR RESTORED AREAS AT THE FERNALD CLOSURE PROJECT

FERNALD CLOSURE PROJECT
FERNALD, OHIO

APRIL 2003

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

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DRAFT

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

A1PI	Area 1, Phase I
A8PII	Area 8, Phase II
CC	coefficient of conservatism
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CW	coefficient of wetness
dbh	diameter at breast height
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FCP	Fernald Closure Project
FQAI	Floristic Quality Assessment Index
FWS	U.S. Fish and Wildlife Service
HEA	Habitat Equivalency Analysis
mg/L	milligrams per liter
mS/cm	microSiemens per centimeter
MSI	Modified Simpson's Index of Diversity
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Agency
NRIA	Natural Resource Impact Assessment
NRRDP	Natural Resource Restoration Design Plan
NRRP	Natural Resource Restoration Plan
NRT	Natural Resource Trustee
NTU	Nephelometric Turbidity Units
OEPA	Ohio Environmental Protection Agency
ROD	Record of Decision
USDA	U.S. Department of Agriculture

EXECUTIVE SUMMARY

The 2002 Consolidated Monitoring Report summarizes and presents data associated with monitoring, maintenance, and management of ecological restoration projects at the Fernald Closure Project (FCP). In 2002, the FCP ecological restoration projects evaluated include the Area 1, Phase I (A1PI) Wetland Mitigation Project, and the Area 8, Phase II (A8PII) Forest Demonstration Project. For each of these projects, implementation phase monitoring results are discussed, along with maintenance and management summaries, and lessons learned. The 2002 Consolidated Monitoring Report also summarizes the Functional Phase Monitoring Program and presents the results of baseline and reference site characterization efforts.

The 2002 implementation phase monitoring for the A1PI Wetland Mitigation Project included woody vegetation survival, herbaceous cover, and sampling for water quality, water elevations, and wildlife observations. Woody vegetation survival was impacted in 2002, with only one basin achieving 80 percent survival. The Natural Resource Trustees (NRTs) have collectively agreed not to maintain 80 percent survival of woody vegetation as documented in the 2001 Consolidated Monitoring Report (DOE 2002a). Herbaceous cover was greatly improved. All basins and the upland area have at or near 90 percent cover and 50 percent or greater native species composition, relative cover, and/or relative frequency. Woody vegetation survival and herbaceous cover data for the wetland mitigation project are provided in Appendix A of the Consolidated Monitoring Report. As in 2001, there will be no planting in the wetland mitigation project in order to minimize further impacts to the existing wetland project vegetation. No actions are required to address herbaceous cover, other than routine maintenance. In general, water quality sampling and water elevation measurements indicate that wetland conditions are developing within the wetland mitigation project, but they are limited to swales and deep pools within each basin. Maintenance activities within the wetland mitigation project included invasive species control and repair of water control structures.

Implementation phase monitoring for the A8PII Forest Demonstration Project included woody vegetation survival, herbaceous cover, and an evaluation of invasive species across the project. Woody vegetation survival was slightly reduced in 2002, but still adequate across most of A8PII. Deer pressure and drought reduced overall survival by approximately 5 percent. Herbaceous cover was adequate across the entire project area. All areas achieved at or near 90 percent cover and 50 percent native species composition, relative cover, and/or relative frequency. No corrective actions are required for herbaceous cover in A8PII outside of routine maintenance. Woody vegetation survival and herbaceous cover data for the

forest demonstration project are provided in Appendix B of the Consolidated Monitoring Report. Invasive species continue to be minimized through maintenance activities, which will continue in 2003.

Functional phase monitoring activities involved the completion of baseline and reference site characterization. To characterize baseline conditions, five different site-specific habitats were identified and surveyed for herbaceous vegetation, woody vegetation, and several wildlife parameters. Baseline communities include grazed pasture, riparian, successional woodlot, pine plantation, and open water. Reference site characterization involved the survey of six different regional communities, including riparian, wet forest, upland forest, open water, wet prairie and upland prairie. Data collected in 2002 is provided in Appendix C of the 2002 Consolidated Monitoring Report. Appendix D details the sampling and analysis methods used to characterize baseline communities at the FCP.

1.0 INTRODUCTION

The purpose of this report is to summarize and present data associated with monitoring, maintenance, and management of ecologically restored areas at the Fernald Closure Project (FCP) for Calendar Year 2002. This report has been prepared as part of an overall restored area monitoring and maintenance strategy set forth in the FCP Natural Resource Restoration Plan (NRRP, DOE 2002b). The NRRP specifies the submittal of an annual monitoring report at the end of each calendar year, starting in 2001.

1.1 BACKGROUND

The 1,050-acre FCP site is undergoing large-scale environmental remediation pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Section 107 of CERCLA imposes responsible party liability for injury to natural resources resulting from the release of a hazardous substance. CERCLA and the National Contingency Plan (NCP) establish certain state and federal agencies as trustees for natural resources. The Natural Resource Trustee (NRT) representatives for the FCP include the Ohio Environmental Protection Agency (OEPA) and the U.S. Fish and Wildlife Service (FWS). The U.S. Department of Energy (DOE) has a dual role as both a trustee and a potentially responsible party. In 1986, the State of Ohio filed a $206 million lawsuit against DOE as compensation for natural resource damages resulting from releases of hazardous substances at the FCP. Action on the natural resource damage claim was stayed until the completion of all site Records of Decision (RODs). Since the signing of the Operable Unit 5 ROD in 1996, DOE has been in negotiations with the other NRTs. A summary of these NRT negotiations is provided below.

DOE identified the other FCP NRTs and made initial contact in 1994. The NRTs agreed to meet and discuss resolution of the Ohio 1986 natural resource damage claim. As stated above, NRT negotiations were underway by 1996. From these discussions, the NRTs tentatively agreed to avoid further litigation and seek compensation for natural resource injuries through the implementation of on-property ecological restoration projects. In 1997, the NRTs signed a tri-party letter that was sent to the U.S. Environmental Protection Agency (EPA) stating this intent. The NRTs then developed a conceptual restoration plan for the FCP site, the NRRP. The plan was preceded by the Natural Resource Impact Assessment (NRIA). The NRIA used existing site data to quantify the extent of past and anticipated natural resource injuries at the FCP. The NRTs used this information to quantify compensatory restoration acreage through a process called Habitat Equivalency Analysis (HEA). The NRIA and HEA processes are explained in greater detail within the NRRP. A draft final NRRP was produced in 1998, and DOE began

implementation of several ecological restoration projects. Revised versions of the NRRP and NRIA were developed in 2002, but has not received final approval of the NRTs (DOE 2002b, 2002c).

Negotiations continued with the NRTs regarding the scope of restoration, compensation for groundwater injury, and the extent of monitoring. In 2001, the NRTs signed a Memorandum of Understanding that formalized the agreement to use on-property ecological restoration as the primary means of compensation. The NRTs also sought to compensate for groundwater injury through a cash settlement, which could be used to develop a series of groundwater education initiatives, perform restored area management and possibly fund an on-site education program. While the fundamental components of the settlement have been established, the NRTs continued to negotiate through 2002 regarding a future end point to the settlement agreement.

The approach for site ecological restoration developed by the NRTs and set forth in the NRRP involves integration of ecological restoration projects into site remediation activities. This will result in the implementation of a series of projects across the site following remediation. In general, site restoration will involve grading to maximize the formation of wetlands or expanded floodplain, amending soil where topsoil is removed, and establishing native vegetation. Restoration projects will usually involve some form of forest establishment, wetland construction, or seeding with native grasses and forbs. Further detail regarding the sitewide ecological restoration approach is provided in the NRRP.

The NRTs have agreed to implement the concept of "adaptive management" during the field implementation, monitoring, and maintenance of restoration projects at the FCP. Adaptive management is defined pursuant to the final NRRP as a continuing process of planning, monitoring, and adjusting, with the objective of improving the project implementation and outcomes (Lessard 1998). The NRTs realize that flexibility is needed to successfully implement restoration and management. The field of ecological restoration is relatively new, and innovative techniques and approaches are being developed all the time. Also, ecological systems are dynamic and dependant on a variety of factors that are difficult to control, such as climate, predation, etc. Because of this, results presented in annual monitoring reports will be used to adjust implementation, maintenance, and monitoring approaches as needed, in order to optimize the progress of restored areas at the FCP. It is important to note that implementation and management of restored areas will be bounded by the scope of work defined in the NRRP.

1.2 RESTORED AREA MONITORING PHASES

Monitoring of restored areas will involve two phases. First, implementation phase monitoring is conducted to ensure that restoration projects are completed pursuant to their Natural Resource Restoration Design Plans (NRRDPs). The second phase of monitoring is termed the functional phase. This effort will consider projects in terms of their system-specific contribution to sitewide ecological communities. The NRRP provides a thorough overview of both implementation and functional phase monitoring. The text below describes the specifics that will be evaluated for each phase.

1.2.1 Implementation Phase Monitoring

The main focus of implementation phase monitoring primarily involves vegetation survival and herbaceous cover. The NRTs have negotiated that 80 percent survival of all planted vegetation must be achieved. In addition, seeded areas must obtain sufficient cover, as defined below. Plant survival rates will usually be calculated on an individual "patch by patch" basis. A patch is a planting unit about 0.25 acre in size that consists of a specific habitat template. This design approach will be used for most of the NRRDPs developed at the FCP.

To determine vegetation survival, mortality counts will be conducted at the end of each growing season. Each balled and burlap or container-grown tree and shrub will be inspected and assigned one of three categories: alive, resprout, or dead. Trees and shrubs will be considered "alive" when their main stem and/or greater than 50 percent of the lateral stems are viable. "Resprout" trees and shrubs will have a dead main stem, with one or more new shoots growing from the stem or the root mass. Plants will also be categorized as "resprout" when less than 50 percent of its lateral branches are alive. Dead trees will have no signs of vitality at all.

Originally, the NRTs negotiated a 90 percent cover survival rate for all seeded areas within a restoration project, to be obtained at the end of the first growing season. The 90 percent cover value is generally applied to cover crops and is needed to ensure slope stabilization and erosion control. For native species establishment, the NRTs have agreed to establish 50 percent native cover at the end of the implementation monitoring period as a goal.

All seeded areas will be evaluated within each restoration project. Depending on the size of the restoration project, seeded areas may be grouped into habitat-specific sub-areas. For each distinct area, at least three one-meter square quadrats will be randomly distributed and surveyed. Field personnel will estimate the total cover and list all species present within each quadrat. The data collected will be used to

determine total cover, percent native species composition, and relative frequency of native species, as described below.

For total cover, the quadrat-specific cover estimates will be averaged. Percent native species composition will be calculated by dividing the total number of species surveyed into the total number of native species present. The relative frequency of native species will be determined as follows. First, DOE will record the number of times each species appears in a quadrat. This value will then be divided by the number of quadrats surveyed to obtain a frequency. Next, the frequencies of all native species will be summed and divided by the total of all frequencies within a given area. The calculation of percent native species composition and relative frequency is similar to the approach for functional phase monitoring, which is described in Appendix D.

By collecting the information described above, DOE will evaluate implementation phase success of seeded areas based on two criteria. First, 90 percent cover must still be met by the end of the first growing season. Second, the goal of 50 percent native species composition or relative frequency must be obtained by the end of the implementation monitoring period. These criteria address both erosion control and native community establishment, which are the two primary goals of seeding in restored areas.

Additional monitoring parameters were presented in the 2001 Consolidated Monitoring Report, including native cover, Floristic Quality Assessment Index (FQAI), and Modified Simpson's Index of diversity (MSI). FQAI and MSI are discussed in more detail in Section 1.2.2 below. Percent native cover is calculated by summing all native species cover estimates and dividing by the total cover of a given area. Appendix E of the 2001 Consolidated Monitoring Report describes the calculation of these parameters. For the purposes of comparison, they have been included in this year's Consolidated Monitoring Report. However, in future years, MSI and FQAI will not be used to evaluate implementation phase monitoring. Instead, FQAI will be one of the main focuses of functional phase monitoring. The functional phase monitoring approach is discussed in Section 1.2.2 below.

Specific NRRDPs may impose additional types of implementation phase monitoring. For instance, water levels must be evaluated for wetland mitigation projects. The duration of implementation phase monitoring is also variable. Vegetation survival will generally be evaluated for one year following installation, while wetland mitigation requirements must be evaluated for three to five years. The NRRP provides a monitoring schedule based on these requirements in relation to anticipated project completion dates.

1.2.2 Functional Phase Monitoring

Functional phase monitoring is not a pass/fail determination like implementation phase monitoring. Instead, functional phase monitoring will evaluate the progress of the restored community against pre-restoration baseline conditions and an ideal reference site. Vegetation indices will be used for comparisons, as well as several wildlife-based evaluations. The Ecological Restoration Functional Phase Monitoring Plan is provided as Appendix D of this report. The monitoring plan details the field methods and data analyses that will be used to implement functional phase monitoring at the FCP. A summary of the specific parameters to be evaluated is discussed below.

Evaluation of woody and herbaceous vegetation is the main focus of functional phase monitoring. The NRTs have discussed the use of a variety of monitoring parameters in an attempt to characterize the extent and quality of restored areas at the FCP. DOE, in conjunction with the NRTs, delineated baseline conditions at the site and initiated characterization in 2001. In 2002, the baseline characterization was completed and ecological reference sites were chosen and surveyed. Section 3 discusses the selection of baseline and reference sites in more detail.

Data collected during baseline and reference site characterizations include species richness, density, and frequency. Woody vegetation size was also recorded. From these parameters, sites are evaluated through FQAI, the extent of native species present, and the extent of hydrophytic species present (for wet areas). These parameters were chosen after two years of baseline and reference site data collection and analyses. Several parameters discussed in the past will not continue to be evaluated at this time. The Modified Simpson's Index of diversity has not proven very useful, as diversity is not a reliable indicator of ecosystem quality. The ease and efficiency of survey must also be taken into consideration. DOE has teamed with the University of Dayton to conduct reference site characterizations and refine sampling methodologies. Survey techniques and data analyses are discussed in Section 3 and Appendix D. From these efforts, DOE feels that the final monitoring parameters summarized above will best represent the extent of native species establishment, development of hydric conditions, and quality of vegetative communities restored at the FCP.

Several wildlife evaluations will be conducted in addition to vegetation surveys. These include amphibian and macroinvertebrate sampling, and migratory waterfowl observations. Casual wildlife observations will also be recorded in each study area. The collection and treatment of migratory waterfowl observations are detailed in Appendix D. Amphibian and macroinvertebrate sampling is conducted by the OEPA and is outside the scope of the Consolidated Monitoring Report.

The schedule for functional phase monitoring is provided in Appendix D and the NRRP. The schedule is set up so that only one type of ecological community will be evaluated in any given year. This year's Consolidated Monitoring Report includes the presentation of baseline and reference data. The baseline systems that were evaluated include grazed pasture, riparian forest, successional woodlot, pine plantation, and open water. Reference sites include an emergent wetland, a beech-maple/oak-hickory forest complex, wet forest, riparian forest, wet prairie and upland prairie.

1.3 PROJECT SUMMARIES

The ecological restoration projects evaluated in this year's Consolidated Monitoring Report include the continued implementation phase monitoring of the Area 1, Phase I (A1PI) Wetland Mitigation Project and the Area 8, Phase II (A8PII) Forest Demonstration Project. Section 4.1 of the NRRP includes a summary of these projects. This consolidated monitoring report also describes the baseline and reference site ecological monitoring program as part of functional phase monitoring.

1.4 METEOROLOGICAL CONDITIONS

Site meteorological conditions effect several major components of ecological restoration projects. Precipitation irrigates planted and seeded vegetation and charges water features. Because of this, site precipitation data is presented on Table 1-1. In general, the spring and fall of 2002 received above-average rainfall, while the summer received below average precipitation. For eight months in 2002, the Palmer drought severity index for southwest Ohio was either "unusual moist spell" or "very moist spell" [National Oceanic and Atmospheric Agency (NOAA) 2001]. Overall, the FCP site received adequate rainfall to support ecological restoration in 2002, and supplemental irrigation was not required for most of the year. While the annual total precipitation was adequate, the site received very little rainfall for mid-June to mid-September. This summer drought stressed established and ongoing restoration projects sitewide. Irrigation was conducted in the Southern Waste Units during the period, so established projects were probably impacted more by the summer dry spell. It should be noted that water was introduced into the wetland mitigation project, in an effort to control invasive species. More information regarding this management activity is provided in Section 2.1.3.

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TABLE 1-1
2002 PRECIPITATION DATA

Month	Average Site Precipitation (in.)	Actual Site Precipitation (in.)	Monthly Departure from Average (in.)	Cumulative Departure from Average (in.)	Palmer Drought Severity Index (as recorded in the last week of the month)
January	3.14	2.08	-1.06	-1.06	unusual moist spell
February	2.80	1.88	-0.92	-1.98	near normal
March	3.90	5.27	1.37	-0.61	unusual moist spell
April	3.80	7.47	3.67	3.06	unusual moist spell
May	4.23	8.57	4.34	7.40	very moist spell
June	4.06	4.82	0.76	8.16	unusual moist spell
July	4.03	0.85	-3.18	4.98	near normal
August	3.20	0.78	-2.42	2.56	moderate drought
September	2.79	5.93	3.14	5.70	near normal
October	2.68	3.80	1.12	6.82	unusual moist spell
November	3.33	2.81	-0.52	6.30	unusual moist spell
December	3.12	4.70	1.58	7.88	very moist spell

4

2.0 IMPLEMENTATION PHASE MONITORING

This section presents the project specifics, results, and corrective measures for implementation phase monitoring at the FCP. In 2002, the A1PI Wetland Mitigation Project and the A8PII Forest Demonstration Project are the only two projects undergoing implementation phase monitoring. This section also summarizes all maintenance and adaptive management activities conducted within these projects during 2002 and provides a discussion regarding lessons learned for each project.

2.1 A1PI WETLAND MITIGATION PROJECT

The wetland mitigation project involved the planting of 3,327 trees and shrubs within 86 different patches across the 12-acre project area (DOE 1999). Field implementation and replanting efforts were conducted in several phases from 1999 to 2002. As stated in the 2001 Consolidated Monitoring Report, implementation phase monitoring and results for the wetland mitigation project will be assessed basin by basin instead of by individual patches. The areas in the wetland mitigation project include the eight interconnected basins (Figure 2-1). All upland areas were also grouped into a single separate area. Patch-specific and community-specific information is included in Appendix A.

2.1.1 Monitoring Parameters

The wetland mitigation design called specifically for implementation phase monitoring. The monitoring effort includes planted vegetation survival, herbaceous cover estimates, measurements of water elevations and water quality, soil sampling, and documentation of wildlife observations. Unless otherwise noted, all monitoring was conducted pursuant to the methods set forth in the Wetland Monitoring Report for the Year 2000 (DOE 2001). Each of these efforts are discussed in more detail below.

2.1.1.1 Vegetation Survival

The A1PI Wetland Mitigation Design required that 80 percent survival must be maintained for planted trees and shrubs (DOE 1999). As outlined in the 2001 Consolidated Monitoring Report, NRTs are not focusing on maintaining 80 percent. The NRTs have decided that improving wetland function is the primary goal for the wetland project. Because of this the 80 percent survival is no longer applicable. Instead, an adaptive management approach will be adopted, and implementation phase woody survival will be discontinued in 2003.

2.1.1.2 Herbaceous Cover

The wetland mitigation design called for 90 percent herbaceous cover in all seeded areas following the first or second growing season (DOE 2001). As stated in Section 1.2.1, the NRTs have agreed to expand the evaluation of seeded areas to include additional parameters, such as percent native species composition and relative frequency. Relative cover of native species is provided as a comparison to 2001 data.

The method for determining herbaceous cover has been modified from the original design. Instead of a patch-specific walkover survey, DOE used randomized quadrats to determine basin-specific cover estimates. For each quadrat, cover class estimates were recorded pursuant to the approach used for functional phase herbaceous surveys described in Appendix E of the 2001 Consolidated Monitoring Report. The original approach proved difficult to implement, because individual seeding patches could not be distinguished (DOE 2001). Quadrat locations across the wetland mitigation project are shown on Figure 2-1.

For the wetland mitigation project, the extent of hydrophytic vegetation is an additional measurement parameter for the herbaceous layer. DOE evaluated hydrophytic vegetation by calculating the average coefficient of wetness (CW) and relative frequency of hydrophytic plants in each area. The U.S. Fish and Wildlife Service Region 1 wetland indicator status was assigned for each species in each area (USDA 2001). The wetland indicator status was then converted to a CW, pursuant to Packard, et al. (1997). The CW is a number from 5 to -5 that corresponds with the species wetland indicator status. A coefficient of wetness of 5 is assigned to upland plants, while a coefficient of wetness of -5 is an obligate species. Plants were considered hydrophytic if they were assigned a coefficient of wetness of -2 or less (-2 equates to a "Facultative Wet" - wetland indicator status). Relative frequency was determined from the sum of all hydrophytic species within each area. In 2004, a systematic wetland delineation will take place, pursuant to the U.S. Army Corps of Engineers Wetland Delineation Manual (1987).

2.1.1.3 Water Level and Water Quality Measurements

Adequate hydrology is the most important determinant of a successful wetland mitigation project (DOE 1999). The wetland mitigation design established several processes for measuring hydrology. First, shallow monitoring wells were installed in each basin. Next, staff gauge locations were established to determine the water depth of several ponds. Water depth measurements were taken in several drainage swales as well. All water level monitoring points are identified on Figure 2-1.

Water quality samples were taken in Basins 1, 2, 4, 5, and 6, where ponding is expected (Figure 2-1). For each sample, the color, odor, temperature, pH, specific conductivity, turbidity, and dissolved oxygen were recorded. The intent of the water quality sampling is to status the health of the aquatic systems. Imbalances or other stresses to a system could result in measurement extremes. Water quality sampling was conducted twice in 2002.

2.1.1.4 Other Monitoring

Soil samples were not taken in 2002, pursuant to the wetland mitigation design. Therefore, the only other 2002 implementation phase monitoring performed in the wetland was wildlife observations. Casual observations have been conducted during field activities in 2001. In addition, several amphibian sampling efforts were conducted by OEPA.

2.1.2 Results and Discussion

The results of the A1PI Wetland Mitigation Project monitoring are presented in Tables 2-1 through 2-5, and in Appendix A. Tables in Section 2 provide basin-specific summary information, while Tables A-1 through A-10 in Appendix A provide patch and area-specific data. A discussion of the specific requirements is presented in Sections 2.1.2.1 to 2.1.2.4. A summary of findings is provided below.

The monitoring established in the wetland mitigation design are intended to answer six questions (DOE 1999). Responses to these questions are provided below, based on the third year of implementation phase monitoring of the A1PI Wetland Mitigation Project.

1. Have the concerns of the reviewing agencies been met?

   Yes. Design, construction, and adaptive management of the A1PI Wetland Mitigation Project have resulted in a diverse and improving wetland ecosystem. Wetland experts from OEPA have noted that, as a mitigation project, the A1PI wetland system is very diverse (Mack 2001). DOE will continue to implement adaptive management principles in conjunction with the agencies and the NRTs, with the intent of improving the wetland system and maximizing the jurisdictional wetland acreage created.

2. Have sufficiently dense wetland plant communities been established?

   Yes, in part. The extent of native vegetation in terms of both density and frequency increased for all but one basin in 2002. The frequency of hydric vegetation also increased in seven of the eight basins. Average CW decreased in every basin as well, indicating movement towards more wetland vegetation. In addition, the FQAI increased for all but on basin. Native wetland communities are continuing to expand and improve.

3. Do surface and groundwater levels support wetland conditions?

   Yes. Water level measurements, herbaceous cover estimates, and soil samples (from 2001) demonstrate that surface and groundwater levels are sufficient. Further maintenance of several water control structures was completed in 2002. These actions appeared to improve and expand the extent of wetlands within the project area. Monitoring and adaptive management will continue as needed.

4. Do surface and groundwater quality fall within parameters indicative of a comparatively healthy system?

   Yes. The third year of monitoring demonstrates that water quality is normal, and that there is an abundance of aquatic life in the system.

5. Have animal populations adapted to wetland systems successfully colonized the site?

   Yes. Wildlife use of the wetland system has met or exceeded expectations.

6. Have wetland soils been created?

   To be determined. Soil samples were not collected in 2002, per the A1PI Wetland Mitigation Design (DOE 1999). Limited sampling in 2001 demonstrated that some hydric soils were being formed. However, a systematic soil survey is not planned until 2004.

As stated above, further detail regarding the specific monitoring efforts used to answer these questions are provided in Sections 2.1.2.1 to 2.1.2.4 below.

2.1.2.1 Vegetation Survival Results

Woody vegetation survival rates are presented in Table 2-1. All areas experienced reduced survival in 2002, and only Basin 3 met 80 percent survival. As in 2001, survival rates are determined according to design quantities instead of the actual number planted. Regardless of the method of calculation, woody vegetation in the wetland mitigation project was severely impacted in 2002.

It appears that a combination of an extremely wet spring followed by drought conditions in the summer (9.38 inches above normal precipitation in March, April and May, 5.6 inches below normal precipitation in July and August, Table 1-1) killed many plants that were already stressed from the previous drought in 1999, as well as continued deer pressure. The heavy clay subsoil in which many trees and shrubs were planted may also be a contributing factor in some areas. Field personnel observed one tree that had not grown any roots beyond its burlapped root ball, four years after installation.

As stated in Section 2.1.1.1, the NRTs have agreed to cease planting additional woody vegetation in the wetland mitigation project. Instead, DOE will focus on improving the extent and quality of herbaceous wetland vegetation across the project area. Implementation of this approach was initiated in 2002 and will continue in 2003. The herbaceous layer has benefited from this revised approach, as discussed below.

2.1.2.2 Herbaceous Cover Results

Herbaceous cover information is presented in Table 2-2. In all categories, the herbaceous layer in the wetland mitigation project showed improvement in 2002. For total cover, the one basin that had insufficient cover in 2001 (Basin 5) increased its cover almost three-fold in 2002. Therefore, all basins and upland areas have adequate or near-adequate total cover.

The extent of native species establishment is expressed in terms of percent native species, relative cover and relative frequency. For 2002, native species continued to expand across the entire wetland mitigation project. In terms of native species composition, all basins and upland areas showed improvement over 2001. In particular, Basins 2, 3, 5 and 7 showed dramatic improvement, suggesting that plug plantings in 2001 and 2002 have been a success. Planted species were identified in each of these areas (Appendix A, Tables A-3, A-4, A-6 and A-8).

Similar improvement is demonstrated when comparing both relative cover and relative frequency. Only Basin 4 and the upland did not show improvement from 2001. Both areas showed heavy infestation by Queen Anne's Lace (*Daucus carota*, Appendix A, Tables A-5 and A-10). It should be noted that the relative cover percentages presented in 2001 have been updated in this year's Consolidated Monitoring Report. The revision is a result of converting the 2001 data to the new statewide coefficient of conservatism (CC) values. This updated list is now used to determine the native status of species. Therefore, some species that were considered non-native in 2001 have been reclassified as native in 2002. The updated CC values also affect FQAI calculations, which are discussed in more detail below.

The calculation of revised FQAI values also demonstrates improvement of the herbaceous layer in the wetland mitigation project. Seven of eight basins had a higher FQAI in 2002, with only Basin 1 and the upland reduced. Basin 1 actually had a higher average CC, so the reduced FQAI is a function of a reduction in the amount of total species surveyed in 2002 (Table 2-2). The lower FQAI in the upland area can be attributed to the continued relatively high percentage of non-native species, as well as the presence

of native, weedy species with CCs of 0 or 1 [i.e., ragweed (*Ambrosia artemisiifolia*, Appendix A, Table A-10)].

MSI did not show similar increases like the other parameters. Diversity was reduced in six of the eight basins. Several factors may contribute to this trend. First, the amount of non-natives is being reduced. Consequently, there appears to be a possible correlation between the frequency of native species and diversity. In two of the three areas that showed increased 2002 diversity, the 2002 relative frequency of native species was reduced (Basin 4 and the upland area). In Basin 2, the MSI increase is due to the relatively high number of total species, coupled with the reduction of non-natives. While other basins had similar reductions of non-natives, the total species lists also reduced, thus lowering MSI values. The reduction in total species is not necessarily a concern. As native grasses and forbs are expanding and crowding out less desirable weeds. Because of this, DOE contends that MSI is of limited value in characterizing seeded areas, and proposes to discontinue its use in future Consolidated Monitoring Reports. As stated in Section 1.2.1 and 1.2.2, MSI will no longer be used to evaluate restoration projects at the FCP.

Based on the success criteria discussed in Section 1.2.1, seeding and plug planting across the wetland mitigation project is mostly a success. All basins and upland areas have at or near 90 percent total cover. All basins achieved 50 percent or greater native species composition, and relative frequency. The upland area is just under 50 percent relative frequency. Therefore, no seeding or planting activities are required for the wetlands mitigation project in 2003. Maintenance of invasive and aggressive species will continue as part of routine maintenance of the project area.

2.1.2.3 Water Level and Water Quality Measurement Results

Water levels of shallow wells and ponds are presented in Table 2-3. The shallow well water depths show a general trend towards increasing hydrological conditions. Water column depths were greater at every location compared to 2001. Pond elevations showed similar increases in two of three instances. Two of four swale depths were deeper than 2001. The water elevation data shows that continued management of water levels is improving hydric conditions in the wetland mitigation project.

Water quality analyses are presented in Table 2-4. In general, the results show a balanced system, with no issues needing immediate attention. The September monitoring event appears to be influenced by the drought conditions in July and August, as three of the five sample points were dry. Dissolved oxygen

concentrations appear driven by temperature and the development of hydric soils, rather than environmental degradation.

2.1.2.4 Other Results

Wildlife observations are summarized in Table 2-6. Observations from 2002 demonstrate continued use of the wetland mitigation project by wildlife. To date, forty-four species of birds have been observed, along with seven species of herptofauna and 12 species of mammals. A northern shoveler was added to the bird list in Spring 2002. This sighting further confirms that the wetland mitigation project is providing valuable habitat to migrating and resident waterfowl.

2.1.3 Maintenance and Management Summary

The A1PI Wetland is a developing wetland that is subject to ongoing management and maintenance to optimize wetland functions. Many of the planned maintenance activities were hindered this past year due to weather. The very wet spring and fall seasons delayed the completion of maintenance and management activities in the wetland in 2002. However, gains were made in increasing native plant populations and repairing project structures. Additionally, efforts will continue in 2003 to control invasive species and aggressive plants.

Maintenance actions for invasive and aggressive plants in the wetland included swiping for cattails (*Typha latiflolia*) and giant reed (*Phagmites australis*), herbicide application for the control of thistle (*Cirsium* spp.), and weedeating to control both thistle and bush honeysuckle (*Amur lonicera*).

Giant reed has been observed in Basins 1, 3, 6 and 7. Cattails are present in just about all emergent areas within the wetland mitigation project. These aggressive species should be controlled or they will quickly over take entire communities and reduce them to monotypes. The frequent rains in the spring made scheduling difficult. Rodeo® application to cattails and giant reed during the spring appeared to have limited success, as recent precipitation diluted the herbicide. A second swiping of giant reed and some cattails did not occur until mid summer. By this time, the extreme dry conditions of summer caused many plants to go dormant including possibly the giant reed. The plants had some browning and burning of leaves but did not appear to be dying. Monitoring of giant reed will be conducted early in Spring 2003 and appropriate application made at the earliest available time to eliminate the giant reed from the wetland.

Plateau® application was planned for the control of thistle in many upland areas of the wetland. The herbicide would control the thistle but would not harm the native species. However, spring rains prevented a spring application and scheduling of labor in early summer hampered efforts to spray the Plateau® during the periods while it would have been most effective. The flowers were able to mature prior to the start of the drought and thus spraying would have very little effect on preventing seed dispersal. Efforts will be made by mid-Spring 2003 to spray the upland areas of the wetlands where thistle is a problem. Plateau® will only have an affect on the thistle and not the shrubs, native grasses, and forbs.

Repellex® fertilizer and deer repellent tablets were placed in the ground around the shrubs of three patches (WS6, US13, and part of WS23) in January 2002. The patches were to evaluate the effectiveness of the tablets in reducing browse. Three tablets were placed around each of the shrubs within a patch. The number of tablets was limited and only a portion of patch WS23 received tablets. The selected patches were in heavy deer traffic areas and previously exhibited heavy browse. The areas were observed during monitoring this fall. There appeared to be less browse within the patches, but drought had its effect on the patches' survival (Appendix A, Table A-1).

Pursuant to the replant strategy described in the 2001 Consolidated Monitoring Report, Basins 2, 4, and 7 were to receive a mixture of wetland forb, rush and grass plugs; and Basin 8 was to receive an upland mixture of plugs. Plugs were placed in Basins 2, 4, and 8. During planting, plugs were concentrated in Basins 2 and 4 and no plugs were installed in Basin 7. However, total cover, native species composition, relative cover, relative frequency, FQAI, average CW, and relative frequency of hydrophytic vegetation all increased in Basin 7 in 2002.

Headwalls were repaired across the wetland mitigation project (Figure 2-1). Carpenters constructed new spillway boards for headwalls in the wetland. The spillway boards were constructed of plastic wood and included plastic wood stoplogs to control water levels within the swales. The spillway boards replaced the wooden boards with V grooves that were originally on the headwalls. A mason later built up concrete lips on the headwall along the base of the spillway boards to reduce leakage under the boards. For the most part, the new spillways were effective in controlling the water level behind each of the headwalls. However, water was observed flowing around the headwall from Basin 6 to Basin 1. Crayfish had tunneled around the headwall and were draining the water from Basin 6. Water levels were high during rain events but dropped dramatically within days. A mini-excavator was brought in to excavate the soil on the western end of the headwall. Carpenters constructed a form. A mason and laborers poured

concrete to extend the headwall four feet to the west across the path where the crayfish built their tunnels. The work was completed during the summer drought so the swale in Basin 6 remained dry until the fall.

Erosion in the spillway from Basin 1 going off property (Figure 2-1) resulted in a washout that required repair. The soil on the eastern side of the spillway washed out above and below the cross log that anchors the spillway berm. Water flow off property was temporarily blocked and clay soil hauled in to fill the gully. Rock and gravel were brought in to create a cascade to protect against further washing of soils. The soils were replaced and compacted with a mechanical compactor. Rock was replaced and adjusted to account for the wider flow zone. The exposed soils further up the slope were seeded and covered with coir matting. Buttonbush (*Cephalanthus occidentalis*) live cuttings were collected from Basins 2 and 6 and driven into the soils of the spillway. Grasses and rushes were transplanted from Basin 1 to the spillway to provide immediate cover for areas having the most water flow. Field observations confirmed that the repair activities were a success.

The stick drain in Basin 5 is draining slower than previous years. In 2002, water levels in Basin 5 remained at a higher level than normal. The heavy rains this spring coupled with the higher levels in the basin resulted in large flows across the emergency spillway to Basin 1. The increased flow resulted in some erosion of the bank of the spillway. The soils were spread out to fill in some of the ruts, and rock was stacked up the hill to create a cascade for the water flow. The spillway was stabilized and flows into Basin 1 are clear with no indications of additional erosion.

The wet prairie in Basin 6 was cut using weedeaters. The grasses and forbs were left on the ground. The grasses within the shrub and tree patches and each water-body were excluded from cutting. The open space became an attractant for turkey; a flock of turkey came daily to peck in the area.

Maintenance activities in 2003 will focus on the continued chemical and mechanical control of giant reed and cattails as determined appropriate, as well as the reduction of invasive weeds in upland areas (i.e., thistle and Queen Anne's lace). Monitoring, maintenance and repair of headwalls and other water control structures will also continue.

2.1.4 Lessons Learned

The Wetland Mitigation Design calls for a decision to be made on whether or not to continue monitoring based on the performance of the system. Woody vegetation survival has been greatly impacted. As

discussed in Section 2.1.1.1, the NRTs have developed an alternative approach for addressing woody vegetation survival, and no more survival counts will be conducted. Other results from the 2002 monitoring effort demonstrate that the A1PI Wetland Mitigation Project is progressing well. Native herbaceous species are expanding, hydrology and water quality are being maintained, and wildlife are utilizing the wetlands. Based on these findings, DOE proposes to discontinue implementation phase monitoring in the wetland mitigation project. This does not mean that no more monitoring will be conducted in the project area. Wetland functional monitoring will commence in 2003. Also, a wetland delineation will be conducted for the project in 2004 per the design in order to determine the extent of wetland creation and obtain Agency approval for the project. In addition, maintenance activities will continue as needed. Additional lessons learned are discussed below.

There has been an increase in the percent native cover with the basins of the Wetland Mitigation Project. The placement of herbaceous plugs in Basins 2, 4 and 8 certainly added to the percent coverage, but was not the greatest contributor. The improvements made to the headwalls appear to have been a significant contributing factor in increasing the percent native cover in the wetland mitigation basins. The new spillway boards allow flexibility in raising and lowering the water levels within those basins. The water in the three basins was raised above previous levels during the spring rain season. This allowed for flooding in some areas that previously remained above the water level. Many of the aggressive species and other undesirable plants in these areas were flooded out. The wet prairie components were able to take advantage of the vacated space to expand. It has been determined that the percent of native vegetation could be maintained or increased each year by temporarily elevating the water level in individual basins during the spring to flood more areas. This can be accomplished by placing stoplogs in spillway boards and sandbags across spillways of basins not having headwalls. Stoplogs and sandbags would be removed after two to three weeks and water levels allowed to return to normal.

Monitoring of the wetland mitigation project has been conducted in the spring or early summer. This year the monitoring took place in the fall. The height of the prairie grasses in the fall made it difficult to find some of the shrubs. The plants are easier to find in the spring with the new growth before the tall grasses get their growth. The monitoring results after the long dry summer drought did not reflect the growth and progress made during the spring growing season. Many of the plants that would have been alive in the spring were identified as dead. Efforts should be made to conduct any additional monitoring of each basin earlier in the growing season.

The deer repellent tablets showed preliminary improvement in survival of shrubs in area where tablets have been replaced. There was still mortality from the drought, but the browse levels in patches that used the Repellex® appeared to be reduced. The tablets are easy to install and last as long as two years. The spray may still be needed for the first few weeks after planting to allow the tablets time to break down and transpire into the plant stems and leaves.

2.2 A8PII FOREST DEMONSTRATION PROJECT

The A8PII Forest Demonstration Project completed its third growing season in 2002. Most planting was completed in Spring 2000. Shrubs and most seedlings were planted in Fall 2000. Some remaining seedlings were planted in Spring 2001. Replanting efforts were initiated in Fall 2002, pursuant to the 2001 Consolidated Monitoring Report. As with the wetland mitigation project, monitoring results will be presented in terms of both system-specific and patch-specific quantities.

2.2.1 Monitoring Parameters

Since this project does not require regulatory-driven mitigation, the Implementation Phase Monitoring Program is less involved than the wetland mitigation project. The forest demonstration project NRRDP established monitoring parameters for vegetation survival and herbaceous cover, as well as an evaluation of invasive species within the project area. These parameters are discussed in more detail below.

2.2.1.1 Vegetation Survival

The A8PII NRRDP calls for 80 percent survival of all planted vegetation, with the exception of seedlings (DOE 2000). It was evident that very little mortality had occurred in A8PII from 2001 to 2002; therefore, a steam-lined approach was used to assess mortality in the project, even though greater error in the method was anticipated. The modified approach is described below.

DOE conducted mortality counts across A8PII in August 2002. For each patch, dead individuals were recorded pursuant to Section 1.2.1. The total number of dead plants in each patch was then compared to the number of dead recorded in 2001. If the number dead in 2002 was greater than 2001, the survival rate was adjusted down accordingly. If the 2001 mortality totals were greater than or equal to the 2002 counts, the original 2001 survival rate was retained. This creates the potential for greater error, because the exact number that are alive are not verified in the field. As stated above, this approach was a revision from the field methods used in 2001. Last year, every plant was accounted for, and recorded as either alive, dead, or missing (missing trees and shrubs were assumed dead for the purposes of tabulating

survival rates). Because of this revised methodology, the NRTs requested that DOE conduct selective "live counts" in order to compare the two approaches. The additional live counts showed very little difference in the two methods (approximately 5 percent error). Therefore, the data collected in August were considered adequate.

2.2.1.2 Herbaceous Cover

Herbaceous cover requirements have been modified for 2002 pursuant to the approach set forth in Section 1.2.1. For A8PII, four quadrats were surveyed in each of the four habitat types. Results are discussed in Section 2.2.2.2 below.

2.2.1.3 Other Monitoring

The only other monitoring for the A8PII Forest Demonstration Project specified in the NRRDP was a report on the status of invasive species across the project area. The status is provided in Section 2.2.2.3 below.

2.2.2 Results and Discussion

The results of implementation phase monitoring for the forest demonstration project are presented in Tables 2-6 and 2-7, and in Appendix B. Tables 2-6 and 2-7 provide summary information organized by vegetative communities, while Tables B-1 through B-5 provide more detailed patch-specific and area-specific data. Figure 2-2 shows the vegetative communities within the project area. These monitoring results are discussed in greater detail below.

2.2.2.1 Vegetation Survival Results

Table 2-6 demonstrates that woody vegetation survival reduced slightly across all areas from 2001 to 2002. Generally, woody vegetation in A8PII appeared to be growing well. Several buckeye and one shingle oak produced mast in 2002. Field personnel also observed numerous recruits across the project area, including box elder, sycamore, cottonwood, buckeye and black walnut. Several cottonwood and sycamore recruits are as large as planted saplings in the oak-maple habitat type.

The slight reduction in seedling and shrub survival is attributable to continued deer pressure and unusual drought conditions during the summer. Drought stress was evident during field surveys in August 2002. A number of buckeye and beech were in the process of dropping leaves and undergoing early dormancy. Rutting bucks damaged many trees across the beech-maple and mesophytic habitat types. Deer tube

protectors appear to be losing their effectiveness, as deer seem to become more accustomed to their presence. Field personnel observed a number of tubes that were damaged by antlers. On a positive note, many damaged trees appear to be responding heartily. While these plants may not eventually contribute to a closed canopy, this is what occurs in any natural succession process and will still provide ecological services in the form of food, cover, etc.

As stated in Section 2.2.1.1, DOE conducted "live counts" on selected patches to compare against the "dead count" method used in 2002. Based on the live count/dead count comparison, the August 2002 mortality approach overestimated survival across the project area by about 5 percent. Therefore, all patch survivals were adjusted down accordingly. Tables 2-6 and B-1 represent these adjusted survival rates.

No further monitoring of woody vegetation mortality will be conducted in A8PII. DOE will evaluate survival across A8PII in both the original planting patches and the replant areas as part of functional monitoring. Functional monitoring for forest restoration projects will be conducted in 2004, pursuant to the NRRP.

2.2.2.2 Herbaceous Cover Results

Herbaceous cover results are presented in Table 2-7. In general, seeded areas across A8PII are maintaining or improving. Total cover across A8PII remained about the same as 2001. There was a slight drop from 2001 in both the oak-maple and savanna habitat types. In the oak-maple area, one of the four quadrats surveyed was assigned a cover class of 4. One quadrat in the savanna was given a cover class of 3. When both of these areas are observed in the field, it appears that cover is adequate.

The native species composition, relative percent native cover and relative frequency stayed the same or increased in every area except the wetland in 2002. While native species composition and relative cover were reduced, the frequency of native species was about the same in the wetland. The reduced relative cover is probably attributable to several large patches of fescue, which accounted for about 25 percent of the total herbaceous density. Fescue dominated the cover in two of four quadrats. Since it was not found in two quadrats, the relative frequency of native species in the wetland area was not as impacted (Appendix B, Table B-4).

FQAI and MSI calculations are as expected. FQAI increased in the two areas that saw substantial increased in native species (the oak-maple, and swale and berm habitat types). MSI was reduced across

all areas in 2002. The reduced diversity is a function of the total number of species surveyed in 2002. Since native species are generally increasing across A8PII and "weedy" species are reducing, the reduced diversity is not a concern. As stated in Sections 1.2.1 and 1.2.2, starting in 2003, MSI will not be used to evaluate herbaceous cover at the FCP.

Based on the criteria established in Section 1.2.1, herbaceous cover in seeded areas within the forest demonstration project has successfully established. Total cover is adequate across the entire project area and native species establishment is greater than 50 percent for all but one parameter in the wetland area. Casual field observations suggest that the wetland area is doing well, especially around the ponds and at the edge of the vernal pool. On the other hand, casual observations do not support that the savanna has met its design goals. Therefore, management considerations of the savanna area will be evaluated in 2003.

2.2.2.3 Other Results

Invasive species across the forest demonstration project area have been reduced. FCP maintenance personnel have conducted an "invasives sweep" across A8PII several times since project completion. Pursuant to the NRRDP, amur honeysuckle (*Lonicera mackii*) and multiflora rose (*Rosa multiflora*) are mechanically removed or sprayed with Roundup® herbicide in the spring and fall of each year. These maintenance activities seem to have a positive effect, as the amount of non-native vegetation appears to be reduced when compared to other areas at the FCP. A more thorough evaluation will be conducted in 2004 as part of functional phase monitoring. Until then, invasive sweeps will continue in 2003.

2.2.3 Maintenance and Management Summary

Maintenance activities in 2002 focused on enhancing the savanna habitat type. The savanna was sprayed with Plateau selective herbicide, then bush hogged. To this point, maintenance activities in the savanna have had some success in increasing native plant coverage.

The herbaceous cover results on Table 2-7 suggest that both native species composition and relative cover are increasing. However, as stated in Section 2.2.2.2, field observations show that, except for several areas near Paddys Run Road and the access path, native species are competing with fescue. Therefore, maintenance of the savanna habitat type is necessary. For 2003 mowing of the area will also continue in order to reduce competition from non-native species.

Other maintenance activities included mowing access paths, weeding around the parking area and removing invasive species, including cattail seed heads in the ponds. Similar maintenance activities will continue in 2003.

2.2.4 Lessons Learned

Lessons learned from the A8PII implementation phase monitoring in 2002 primarily involve refining methods for woody vegetation survival. As stated in Section 2.2.2.1, the use of "dead counts" under represented 2002 mortality by approximately 5 percent. When comparing the efficiency of "dead counts" with the corresponding "live count" verification, the same problems encountered in 2001 still were a concern in 2002. The problems included a difficulty in finding plants and determining appropriate patch boundaries. To address these issues, trees and shrubs can be individually identified and tracked. As stated in Section 2.2.2.1, 2002 was the last year for implementation phase monitoring in A8PII. Unique identification of woody vegetation will be implemented in the Southern Waste Units and North Pine Plantation.

The difficulty in finding some shrubs in the oak-maple habitat type revealed a more fundamental concern of conflicting goals within a restoration project. Most of the oak-maple area was seeded with native grasses and forbs. As discussed in Section 2.2.2.2, the herbaceous layer in the oak-maple patches is progressing very well. Consequently, woody shrubs and small trees may be crowded out. During the "live count" verification, several shrubs within the oak-maple patches were found dead in the midst of dense stands of native grasses. If the goal for the oak-maple habitat type is closed-canopy forest, the use of tallgrass prairie natives may not be the most appropriate seed mix. Instead, seed mixes that maximize volunteer recruitment, improve soils, and stabilize slopes may be more appropriate. This issue requires further discussion among the NRTs and potential revision to the seed specification.

TABLE 2-1
A1PI WETLAND MITIGATION PROJECT
WOODY VEGETATION SURVIVAL SUMMARY

Basin	Survival (%)	
	2001	2002
1	81%	37%
2	78%	53%
3	105%	87%
4	75%	38%
5	49%	21%
6	93%	73%
7	79%	59%
8	93%	30%
Upland	62%	37%

TABLE 2-2
A1PI WETLAND MITIGATION PROJECT
HERBACEOUS COVER SUMMARY

	Total Cover (percent)		Total Species		Native Species (percent)		Native Relative Cover (percent)		Native Relative Frequency (percent)		Average CC		FQAI		MSI		Average CW		Hydrophytic Relative Frequency (percent)	
Basin	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**
1	90%	90%	26	16	73%	94%	78%	78%	75%	89%	1.50	1.69	7.65	6.75	37.1	11.6	-1.26	-2.81	56%	75%
2	88%	90%	27	26	44%	73%	31%	70%	39%	67%	1.33	2.04	6.93	10.39	25.3	38.3	1.19	-1.25	29%	46%
3	87%	90%	18	14	50%	93%	32%	97%	38%	96%	1.06	2.23	4.48	8.35	15.5	11.8	0.25	-4.79	25%	100%
4	97%	90%	18	26	61%	73%	61%	58%	61%	53%	1.22	1.35	5.19	6.86	22.1	28.3	-0.29	-1.25	39%	40%
5	28%	85%	6	9	28%	78%	44%	63%	50%	72%	1.67	1.83	4.08	5.50	6.0	5.9	-2.50	-3.75	50%	72%
6	91%	85%	25	17	72%	76%	68%	77%	65%	76%	1.04	1.65	5.20	6.79	27.8	24.5	-0.79	-1.87	74%	59%
7	98%	100%	23	19	57%	68%	50%	70%	52%	69%	1.35	1.58	6.46	6.88	35.1	14.4	-0.52	-1.35	42%	55%
8	97%	95%	27	14	37%	71%	33%	53%	37%	60%	0.89	1.93	4.62	7.22	22.6	11.7	0.77	-0.73	21%	33%
upland	94%	95%	31	23	45%	52%	55%	47%	49%	45%	1.52	1.43	8.44	6.88	20.6	32.0	2.81	3.35	4%	0%

Native Relative Cover - Summed cover of native species divided by the total cover of all species
Native Relative Frequency - Summed frequency of native species divided by the total frequency of all species
CC - Coefficient of Conservatism (0 to 10)
FQAI - Floristic Quality Assessment Index
MSI - Modified Simpson's Index of Diversity
CW - Coefficient of Wetness (5 to -5)
Hydrophytic Relative Frequency - Summed frequency of hydrophytic species (CW less than or equal to -2) divided by the total frequency of all species

TABLE 2-3
A1PI WETLAND MITIGATION PROJECT
WATER LEVELS

	Shallow Monitoring Well Depth (feet)		Pond Depth (feet)		Swale Depth (feet)	
Basin	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**
1	0.5	1.03	1.9	1.69	1.9	1.69
2	0.33	1.05	1.74	2.04	0.72	1.49
3	0.57	underwater	na	na	0.98	1.60
4	1.34	underwater	1.3	1.56	1.12	0.97
5	0.73	underwater	na	na	na	na
6	0	1.12	na	na	Dry	na
7	0	1.08	na	na	Dry	na
8	0	0.42	na	na	Dry	na

na = not applicable

TABLE 2-4
A1PI WETLAND MITIGATION PROJECT
WATER QUALITY SUMMARY

	Color		Odor		Temp. (Celcius)		pH		Specific Conductivity (mS/cm)		Turbidity (NTU)		Dissolved Oxygen (mg/L)	
Basin	**May**	**Sept.**	**May**	**Sept.**	**May**	**Sept.**	**May**	**Sept.**	**May**	**Sept.**	**May**	**Sept.**	**May**	**Sept.**
1	clear	(dry)	none	(dry)	25	(dry)	8.8	(dry)	0.55	(dry)	0	(dry)	16.8	(dry)
2	Light green tint	light gray	none	None	25	19.8	7.8	7.7	0.18	0.304	30	55	13.8	4.92
4	clear	clear	none	none	28	19.7	8.9	7.25	0.17	0.218	10	5	10.6	4.38
5	Brown tint	(dry)	none	(dry)	26	(dry)	7.8	(dry)	0.47	(dry)	11	(dry)	6.8	(dry)
6	clear	(dry)	none	(dry)	27	(dry)	7.7	(dry)	0.7	(dry)	20	(dry)	7.8	(dry)

mg/L - milligrams per liter
mS/cm - microSiemens per centimeter
NTU - Nephelometric Turbidty Units

The May sampling event was conducted 5/29/02, 75 degrees farhenheit, overcast conditions
The September sampling event was conducted 9/26/02, 63 degrees farhenheit, cloudy and rainy conditions

TABLE 2-5
A1PI WETLAND MITIGATION PROJECT
WILDLIFE OBSERVATIONS

Birds

Red-Winged Blackbird
Wood Duck
Blue-winged Teal
Mallard
Great Blue Heron
Canada Goose
Bufflehead
Red Tailed Hawk
Green Heron
American Goldfinch
Northern Cardinal
Turkey Vulture
Belted Kingfisher
Killdeer
American Crow
Blue Jay
Kestrel
American Coot
Common Snipe
Barn Swallow
Hooded Merganser
North American Turkey
Wild Turkey
Northern Mockingbird
Brown-Headed Cowbird
Black Crowned Night Heron
House Sparrow
Indigo Bunting
Sora
Purple Martin
Common Grackle
Eastern Bluebird
Eastern Meadowlark
European Starling
Tree Swallow
Brown Thrasher
Lesser Yellowlegs
Greater Yellowlegs
Solitary Sandpiper
House Wren
American Robin
Eastern Kingbird
Mourning Dove
Northern Shoveler*

Herpetofauna

Cricketfrog
Marbled Salamander
American Toad
Northern Watersnake
Spring Peeper
Bullfrog
Green Frog

Mammals

Field Mouse
Coyote
Striped Skunk
Meadow Vole
Mink
White-Tailed Deer
North American Raccoon
Gray Squirrel
Fox Squirrel
Cottontail Rabbit
Gray Fox
Red Fox
Muskrat*
Woodchuck (groundhog)*

Other

Crayfish species

* New sightings for 2002

TABLE 2-6
A8PII FOREST DEMONSTRATION PROJECT
WOODY VEGETATION SURVIVAL SUMMARY

Percent Survival by Patch and Area

Existing Riparian			Mesophytic			Beech Maple			Oak Maple			Savanna			Buffer		
Patch	**2001**	**2002**	**Patch**	**2001**	**2002**	**Patch**	**2001**	**2002**	**Patch**	**2001**	**2002**	**Patch**	**2001**	**2002**	**Patch**	**2001**	**2002**
RP1	83%	73%	MM8	93%	88%	BS23	90%	86%	OS1	71%	67%	SV1	58%	55%	BF31	83%	79%
RP2	82%	78%	MM9	88%	73%	BS24	83%	79%	OS2	82%	78%	SV2	50%	48%			
RP3	63%	60%	MM10	85%	81%	BS25	83%	79%	OS3	84%	79%	SV3	25%	24%			
RP4	44%	42%	MM11	86%	82%	BS26	82%	78%	OS4	84%	80%	SV4	78%	74%			
RP5	89%	81%	MM12	80%	76%	BS27	86%	81%				SV5	60%	57%			
			MM13	88%	76%	BS28	86%	81%				SV6	59%	56%			
			MM14	83%	79%	BS29	82%	78%				SV7	50%	48%			
			MM19	84%	80%	BS30	75%	71%				SV8	77%	73%			
			MM20	83%	64%							SV9	56%	53%			
			MM21	81%	77%							SV10	31%	29%			
			MM22	73%	69%												
Totals:	78%	72%		83%	78%		84%	80%		80%	78%		54%	52%		83%	79%

TABLE 2-7
A8PII FOREST DEMONSTRATION PROJECT
HERBACEOUS COVER SUMMARY

	Total Cover (percent)		Native Species (percent)		Native Relative Cover (percent)		Native Relative Frequency (percent)		Average CC		FQAI		MSI	
Area	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**
oak-maple habitat type	100%	90%	58%	58%	56%	71%	57%	68%	1.48	1.95	8.26	8.49	32.1	16.7
savanna habitat type	100%	85%	54%	71%	40%	58%	47%	50%	1.46	2.43	7.75	6.43	36.0	5.9
wetland area	100%	100%	68%	57%	55%	46%	60%	59%	1.81	1.93	10.06	7.22	26.1	11.8
Drainage swales, berms, and the material handling area	90%	100%	59%	89%	57%	96%	54%	94%	1.86	3.44	10.03	10.33	29.6	4.6

Native Relative Cover - Summed cover of native species divided by the total cover of all species
Native Relative Frequency - Summed frequency of native species divided by the total frequency of all species
CC - Coefficient of Conservatism (0 to 10)
FQAI - Floristic Quality Assessment Index
MSI - Modified Simpson's Index of Diversity

3.0 FUNCTIONAL PHASE MONITORING

The approach and methodology for functional phase monitoring is discussed in Section 1.2.2 and Appendix D. In general, functional phase monitoring of restored areas at the FCP consists of comparing restoration projects to the pre-remediation condition of the area and to an end-use reference site. For 2002, baseline and reference site characterizations were completed. Functional phase monitoring of restored areas will begin in 2003. The baseline and reference site characterizations are discussed below.

3.1 BASELINE SITE CHARACTERIZATION

To establish the pre-remediation ecological status, the FCP site was divided into six unique "Baseline Conditions." The six baseline conditions include grazed pasture, riparian, successional woodlot, pine plantation, open water, and developed areas (Figure 3-1). All restoration projects at the FCP will be compared to one of these six baseline conditions, depending on the location of the project. For instance, the A8PII Forest Demonstration Project will be compared to grazed pasture, since the project area was a grazed pasture prior to restoration. For restoration in developed and/or remediated areas, the baseline condition is an uncharacterized developed area. In this case, it is assumed that the project area provided no ecological benefit prior to restoration, and the baseline state is essentially zero for all monitoring parameters. The A1PI Wetland Mitigation Project falls into this category, since soil remediation took place across most of the project area prior to restoration activities.

Characterization of baseline conditions at the FCP was conducted in 2001 and 2002. Vegetation surveys were conducted pursuant to the methods described in Appendix E of the 2001 Consolidated Monitoring Report (DOE 2002a). Figure 3-1 shows the location of permanent transects through each of the characterized areas. Results of the baseline characterization are discussed in Section 3.3 below.

3.2 REFERENCE SITE CHARACTERIZATION

Reference sites were also characterized in 2002. The NRTs agreed on a set of six reference sites that represent the potential end-state for at least a portion of each restoration project at the FCP. Reference sites include a forested riparian corridor, wet forest, an upland forest complex, open water/emergent wetlands, wet prairie, and upland prairie. All of the reference sites were surveyed from four separate areas, three of which are located around the Dayton area. Figure 3-2 is an aerial photo of the Xenia Prairies, which includes the riparian forest, wet prairie, and upland prairie reference sites. The "upland forest complex" is located within Sugar Creek Reserve, which is shown on Figure 3-3. The upland forest complex represents the transitioning mosaic from oak hickory to beech maple forests found in southwest

Ohio. Figure 3-4 is an aerial photo of the Fairborn Marsh, which represents the open water/emergent wetland reference site. The wet forest reference site is found adjacent to the FCP off of Paddys Run Road. This area is shown on Figure 3-5.

The University of Dayton characterized all reference sites in 2002. The methodologies used for characterization are described in Appendix D. The University of Dayton evaluated and revised the baseline characterization methodologies to optimize sampling efficiency and improve representativeness of the data. These revised methods will be used for future restoration project characterizations at the FCP. The reference site characterizations focused on vegetation and migratory waterfowl in open water areas.

3.3 VEGETATION SURVEY RESULTS

Baseline and reference site characterization summaries are presented in Tables 3-1 and 3-2. Site-specific data summaries are provided in Appendix C. As expected, the reference sites are of much better quality than the baseline sites. In general, all reference sites demonstrate better conservatism, total species, and native composition compared to baseline sites. This is especially true of the herbaceous layer. The highest herbaceous FQAI for a baseline site was the successional woodlot (12.37). This value is almost half of 23.96, which is the herbaceous FQAI for the upland forest complex, the lowest herbaceous FQAI for a reference site. The dramatic differences can be attributed to the amount of native species surveyed in both sets of locations. No baseline site had more than 73 percent native species, while no reference site had less than 88 percent native species. The relative frequency of native species is more similar for a couple of sites. However, the increased conservatism of the reference sites (as demonstrated by average CC values) shows that the native species that are present are of higher quality than baseline locations.

Woody vegetation is more similar, given the fewer number and similarity of species (Appendix C, Tables C-6 to C-8, C-15 to C-17). Both baseline and reference sites have a low number of non-native species. However, the small number of non-natives have a large influence on the woody composition of most baseline and reference sites. All but one reference site (wet forest) have lower relative densities of native species when compared to percent native species composition. These lower relative densities are mostly caused by infestations of amur honeysuckle and multiflora rose. The very low relative density for native species in the pine plantation can be attributed to the large number of white pine (*Pinus strobus*) and Australian pine (*Pinus nigra*) that were surveyed in 2001 and 2002. These two species accounted for over 50 percent of the relative density in the pine plantation (Appendix C, Table C-8).

The extent of hydrophytic vegetation is as expected, with only the open water and wet prairie reference sites having average CW values below zero and relative frequency of hydrophytic vegetation near or over 50 percent. The baseline open water location is impacted by a large number of non-native upland weeds (Appendix C, Table C-5).

3.4 MIGRATORY WATERFOWL RESULTS

As stated above, reference site characterization focused on migratory waterfowl in addition to vegetation. Waterfowl observations were conducted at the open water reference site in Spring 2002. Results are shown in Table 3-3. The open water baseline characterization results from 2001 are also provided for comparison.

The open water reference site had eight more species than the baseline site. Waterfowl at the baseline site were limited to common generalists (Canada geese and mallards). On the other hand, waterfowl at the reference site included several high-quality migrants, suggesting that the location is an important habitat for migratory waterfowl. It should be noted that many of the species documented at the reference site have also been observed in the A1PI Wetland Mitigation Project.

3.5 ACTIVITIES PLANNED FOR 2003

2003 is the first year for comparison of restoration projects to baseline and reference sites. Pursuant to the schedule set forth in Appendix D, restored wetland communities will be evaluated in 2003. Wetland systems to be surveyed include the A1PI Wetland Mitigation Project, the A8PII Forest Demonstration Project and the Radium Hot Spot. Both the Southern Waste Units and the Northern Pines Plantation are actively being restored, so they will not be evaluated at this time.

The three areas listed above will be surveyed pursuant to Appendix D. Data analysis and comparison will also be conducted according to Appendix D, and reported in the 2003 Consolidated Monitoring Report. The baseline condition for the wetland mitigation project and the radium hotspot is a developed area. For the forest demonstration project, the baseline condition is a grazed pasture. All three areas will be compared to the open water reference site. Portions of the wetland mitigation project will be evaluated against the wet prairie reference site as well.

As stated in Section 1.2.2, projects will be evaluated by comparison of FQAI, native species composition, and the extent of hydrophytic vegetation. Monitoring results and discussions will be presented in the 2003 Consolidated Monitoring Report.

TABLE 3-1
FUNCTIONAL PHASE MONITORING BASELINE
AND REFERENCE SITE HERBACEOUS DATA SUMMARY

	Conservatism		Species				Hydrophytic Vegetation	
Site	**Avg. CC**	**FQAI**	**Total**	**Native**	**Percent**	**Relative Frequency**	**Avg. CW**	**Relative Frequency**
Baseline Summary								
Grazed pasture	0.42	2.60	38	15	39%	23%	2.27	10%
Riparian	1.97	12.17	38	25	66%	60%	0.84	12%
Woodlot	1.84	12.37	45	31	69%	67%	1.03	12%
Pine plantation	1.73	9.49	30	22	73%	75%	0.62	18%
Open water	1.12	6.44	33	16	48%	38%	0.86	19%
Reference Site Summary								
Riparian	2.99	27.22	83	73	88%	85%	0.12	34%
Wet forest	3.41	28.34	69	61	88%	78%	1.93	18%
Upland forest complex	3.46	23.96	48	44	92%	85%	1.55	12%
Open water	3.49	27.27	61	55	90%	93%	-1.33	59%
Wet prairie	3.56	36.83	107	97	91%	93%	-1.03	49%
Upland prairie	3.26	30.59	88	81	92%	92%	1.31	17%

CC - Coefficient of Conservatism (0 to 10)
FQAI - Floristic Quality Assessment Index
CW - Coefficient of Wetness (5 to -5)

TABLE 3-2
FUNCTIONAL PHASE MONITORING BASELINE AND REFERENCE SITE WOODY DATA SUMMARY

	Conservatism		Species				Hydrophytic Vegetation		Size
Site	Avg. CC	FQAI	Total	Native	Percent	Relative Density	Avg. CW	Relative Density	Avg. DBH (cm)
Baseline Summary									
Riparian	3.64	17.06	22	19	86%	77%	1.35	12%	16.8
Woodlot	3.90	17.44	20	18	90%	51%	0.94	6%	17.6
Pine plantation	2.92	10.54	13	9	69%	22%	1.90	4%	11.4
Reference Site Summary									
Riparian	3.78	18.14	23	21	91%	60%	1.43	5%	10.5
Wet forest	4.83	16.74	12	12	100%	100%	1.42	4%	16.6
Upland forest complex	4.65	20.80	20	18	90%	81%	2.60	1%	13.9

CC - Coefficient of Conservatism (0 to 10)
FQAI - Floristic Quality Assessment Index
CW - Coefficient of Wetness (5 to -5)
DBH - Diameter at Breast Height

TABLE 3-3
FUNCTIONAL PHASE MONITORING BASELINE AND REFERENCE SITE MIGRATORY WATERFOWL OBSERVATIONS

No.	Common Name	Species	Quantity	
			2001 Baseline	2002 Reference
1	Canada goose	*Branta canadensis*	38	101
2	Mallard	*Anas platyhynchos*	13	43
3	blue-wing teal	*Anas discors*	0	17
4	gadwall	*Anas strepera*	0	15
5	green-wing teal	*Anas crecca*	0	12
6	wood duck	*Aix sponsa*	0	4
7	American coot	*Fulica americana*	0	3
8	hooded merganser	*Lophodytes cucullatus*	0	3
9	pie-billed grebe	*Podilymbus podiceps*	0	3
10	American wigeon	*Anas americana*	0	1

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APPENDIX A

A1PI WETLAND MITIGATION PROJECT DATA

APPENDIX B

A8PII FOREST DEMONSTRATION PROJECT DATA

APPENDIX C

FUNCTIONAL PHASE MONITORING DATA

APPENDIX D

ECOLOGICAL RESTORATION FUNCTIONAL PHASE MONITORING PLAN

APPENDIX D
TABLE OF CONTENTS

LIST OF FIGURES

APPENDIX D
ECOLOGICAL RESTORATION FUNCTIONAL PHASE MONITORING PLAN

D.1 INTRODUCTION

The Functional Phase Monitoring Plan presents the field collection, data analysis, and reporting methods that will be used to implement the ecological restoration Functional Phase monitoring program at the FCP. This information is included as an appendix to the 2002 Consolidated Monitoring Report for Restored Areas at the FCP. This plan will be updated as needed and included as an appendix in future Consolidated Monitoring Reports. Functional Phase monitoring will be the primary means of evaluating the progress of ecological restoration at the FCP. In general, Functional Phase monitoring involves the characterization of ecological systems within restored areas, and comparison of those systems to both the baseline pre-remediation conditions and an appropriate reference site. Characterization will require the collection and analysis of several ecological parameters, which will then be reported and used as a basis of comparison between the restored system, the baseline condition, and the end-point reference site. Section 1.2.2 of the Consolidated Monitoring Report provides an overview of the Functional Phase monitoring approach.

The scope of this monitoring plan is mostly limited to the methods needed to conduct Functional Phase monitoring. Field activities required for Implementation Phase monitoring, such as mortality counts, are described in project-specific Natural Resource Restoration Design Plans (NRRDPs), as well as Section 1.2.1 of the Consolidated Monitoring Report. However, it should be noted that certain Implementation Phase monitoring initiatives might utilize the methods described in this plan. For example, herbaceous cover estimates may be implemented pursuant to the process described in Section 3.2 of this plan. When such methods are used, this appendix will be referenced in the discussion of the Implementation Phase monitoring results.

D.2 FUNCTIONAL PHASE MONITORING COMPONENTS

Baseline sites, restored areas, and reference sites will be evaluated using two main components: vegetation characterization and wildlife observations. Vegetation characterization will involve the development of a suite of measured and calculated parameters that define the extent of native species, the quality of species and the extent of hydrophytic vegetation present. Wildlife observations will involve surveys for migratory waterfowl, amphibians, butterflies, and macroinvertebrates. The processes for data collection and analysis of the vegetation characterization and bird surveys are provided in Sections D.3

and D.4 of this plan. Amphibian, butterfly, and macroinvertebrate surveys are conducted by OEPA, so sample and analysis methods are not discussed in this plan.

D.3 VEGETATION CHARACTERIZATION

Vegetation characterization using the parameters discussed above will involve separate sampling and analysis for woody and herbaceous layers. For herbaceous vegetation, species richness and frequency will be collected. For woody vegetation, species richness, abundance and size will be collected. Sampling methods and processes for data analysis are discussed below.

D.3.1 Sample Design

Study areas will be characterized through the use of belt transects. The location of transects will be established as follows. First, field personnel will walk-down the study area and develop a cover map that corresponds to the reference site communities described in Section 5.2. Based on this walk-down, the location of permanent transects will be determined. The number and length of transects will depend on the size of the area to be characterized. In general, the total length of all transects will not exceed 100 meters. Transect locations will be surveyed and identified on the cover map. Transects will usually be laid out in a straight line. In some instances (i.e., a small strip of vegetation surrounding open water), transects will conform to the area needing characterization. Once the transects are established, data collection can proceed.

D.3.1.1 Herbaceous Data Collection

As stated above, herbaceous vegetation will be characterized via species richness and frequency. To determine species richness, all species within one meter on either side of a permanent transect will be identified. These two-meter wide strips will be surveyed three times during the growing season. The first survey will be conducted in early spring, the second in early summer, and the third in late summer/early fall.

A Herbaceous Vegetation Field Data Sheet (Figure D-1) will be generated for each survey (spring, summer, fall) in each study area. If more than one transect is established within an area, then each transect will also be recorded on a separate data sheet. Field personnel will generate a unique number for designating each area, survey and transect. These codes, along with individual species numbers, will be used to label species and quadrats as needed.

Plants that fall within a belt transect will be identified to species in the field and recorded on the field data sheet. If species are unable to be identified, a digital photo and/or a voucher specimen shall be collected for later identification. Record the unknown species on the field data sheet and note the collection of photos or vouchers.

Once the belt transect survey is completed, one square meter quadrats will be randomly placed within the belt transect(s). Field personnel will randomize placement by dividing the total transect length by the number of quadrats to be sampled and randomly placing each quadrat within that portion of the transect. Typically, ten quadrats will be surveyed during each sampling event. However, smaller sites may require less quadrats.

Species within a quadrat will be identified on the field data sheet. The quadrat location is then labeled and flagged in the field and a digital photo is taken. Quadrat location flags shall remain in the study area for the entire growing season. If quadrat placement overlaps quadrats from a previous survey, the new quadrat location will be adjusted.

If Herbaceous Vegeatation Field Data Sheets are used for implementation monitoring, then total cover estimates of each quadrat will be recorded as well. Cover classes will be used instead of percentages. For 2002, a sixth cover class has been added that represents 90 to 100 percent of cover. This additional class is needed to determine the 90 percent total cover requirement for seeded areas at the FCP. Cover classes are designated on the Herbaceous Vegeatation Field Data Sheet (Figure D-1).

D.3.1.2 Woody Data Collection

Woody vegetation data survey involves the collection of species richness, abundance and size. Sampling involves identifying all trees and shrubs within ten meters on either side of the permanent transect(s) within each study area. Field personnel will identify each tree or shrub to species and record it on the Woody Vegeatation Field Data Sheet (Figure D-2). For unknown species, field personnel shall photograph the plant and/or take a voucher specimen for later identification. All photographs and voucher specimens shall be noted on the field data sheet.

For each individual tree, measure the dbh (diameter at breast height) in centimeters with either a dbh tape or calipers. Shrub species will be identified to species but not measured. Only trees and shrubs over one meter tall will be included in the woody plant surveys.

Since woody vegetation remains rather constant through the growing season, only one survey is needed. Also, quadrats are not needed since all individuals will be accounted for.

D.3.2 Data Analysis

From the data collected in the field, several characterization parameters can be developed. As stated in Section D.2 of this plan, vegetation survey efforts will demonstrate the extent of native species composition, the quality of the community, and the extent of hydrophytic vegetation present (when applicable). To accomplish this, the following parameters have been chosen for comparison: average coefficient of conservatism (CC), Floristic Quality Assessment Index (FQAI), total species, percent total native species, relative frequency of native herbaceous species, relative density of native woody species, average coefficient of wetness (CW), relative frequency of herbaceous hydrophytic species, relative density of hydrophytic woody species, and size of woody vegetation.

The CC is a number from 0 to 10 that represents the extent of conservatism for a given species. Non-native species and aggressive weeds receive a CC of 0, while rare species with specialized habitat requirements are assigned a CC of 10. CC values for all species across Ohio have recently been released (Mack 2002), and all baseline and reference site data have been converted to these updated values. The statewide CC list was also used to designate whether a species is considered native or non-native. FQAI is calculated from the CC values. As discussed earlier, FQAI quantifies the quality of vegetation within a given area. The application of FQAI was developed as a monitoring technique for remnant prairies in northeast Illinois (Packard 1997).

The CW is a numerical representation (from 5 to -5) of the U.S. Fish and Wildlife Service (FWS) Wetland Indicator Status designation for each species. An upland plant has a CW of 5, a facultative plant has a CW of 0, and an obligate wetland plant has a CW of -5. Therefore, the lower the CW, the more hydrophytic the plant. Established FWS Region 1 Wetland Indicator Status designations (USDA 2002) were converted to CW values for all baseline and reference site species. A species is considered hydrophytic if it has a CW of -2 or lower. A -2 CW is equivalent to a "Facultative Wetland - Wetland Indicator Status." The size of woody plants will be compared by measuring diameter at breast height (dbh).

Each of these parameters is discussed in more detail below. However, in order to develop these parameters, the survey area data must be organized. First, a list shall be compiled of all species identified during each sample event. Tabulate the woody vegetation abundance and mean dbh area for each species.

For herbaceous species, total the number of quadrats that a species was observed in. If a species was listed in the belt transect survey but not observed in a quadrat, assign it a value of one. Individual vegetation parameters can now be calculated.

D.3.2.1 Native Species Composition

The extent of native species will be presented in terms of percent native composition, relative frequency for herbaceous species, and relative density for woody vegetation. To calculate percent native composition, the total number of native species is divided by the total number of species surveyed for the study area. The result represents the percentage of native species present in a given area.

To calculate the relative frequency of native species, the following steps are required. First, the total number of times a species is identified in a quadrat is summed. This number is then divided by the number of quadrats surveyed. This value is the frequency of a species, defined in terms of species/quadrat. The relative frequency is then determined by dividing each species-specific frequency into the summed total frequency of all species. Relative native frequency is finally determined by summing all native frequencies and calculating as one.

Relative native density for woody species is similarly calculated, except that abundance values are used instead of frequency. Native species abundance is divided the area surveyed to determine density, then by total abundance to determine the relative density of native species.

D.3.2.2 FQAI

FQAI for each study area is then calculated using the following formula:

$$FQAI = C\sqrt{n}$$

Where:

C = the mean CC value of all species
n = the total number of species recorded

The FQAI is a value that can be used to compare the extent of floristic quality between baseline sites, restored areas, and reference sites (Packard 1997). A separate mean CC and FQAI will be calculated for herbaceous and woody vegetation. It is suspected that baseline sites will have a relatively low FQAI when compared to reference sites. Restored areas should show some increase in FQAI values over time. The use of FQAI to compare sites is discussed in Section 5.3 below.

D.3.2.3 Plant Size

This survey parameter applies only to woody vegetation. The mean dbh area of each study area will be established by obtaining species-specific dbh measurements in the field. The mean dbh of a study area is then calculated and reported.

D.3.2.4 Extent of Hydrophytic Species

Hydrophytic species composition is presented in terms of mean CW and frequency or density of hydrophytic species. Species-specific CW values are averaged and presented as a mean CW for each area. The relative frequency or density of hydrophytic species is calculated the same way as relative native frequency or density. Hydrophytic species are summed and treated as one.

D.4 BIRD SURVEYS

Migratory waterfowl observations will be made in open water areas. Field implementation and data analysis is not as involved as that for vegetation characterization. Migratory waterfowl observations shall be conducted in March, during the peak of the spring migration season. Observe the water body in the morning from the same location on five occasions, recording species and quantities observed. Record the date, time, weather, observation location, and observer.

D.5 REPORTING

Once all measurement parameters are calculated for each study area, they must be compared in order to demonstrate the extent of progress for restored areas. As stated in Section D.1 of this plan, restored ecosystems at the FCP will be compared to pre-remediation baseline conditions and to off-property reference sites. This evaluation of restored areas is discussed in more detail below.

D.5.1 Baseline Conditions

The FCP site has been divided into six different pre-remediation baseline conditions: grazed pasture, riparian forest, successional woodlot, pine plantation, open water, and developed. A representative baseline system will be characterized using the processes discussed in Sections D.3 and D.4 of this plan. These representative systems will serve as the baseline template for similar areas across the site. Once an area is ecologically restored, the ecological system components that comprise the restored area will be compared to the baseline conditions present prior to restoration. Project-specific NRRDPs or annual consolidated monitoring reports will specify the applicable baseline condition for the project area. Usually, only one baseline condition will be assigned to a project area. Larger restoration projects may require comparisons to several baseline conditions.

Most of the restoration projects will be established on developed land. In this case, ecological baseline conditions would be considered non-existent. For other areas, however, the restored ecosystems will be compared to the measurement parameters calculated for the applicable baseline condition. It is important to note that baseline conditions are area-based, while restored area evaluations will be ecosystem based. For example, a grazed pasture is restored to an emergent wetland and a wet meadow. When functional phase monitoring for the emergent wetland is conducted, it will be compared to the area-specific conditions that were present prior to the restoration effort. In this example, the baseline comparison would be to the grazed pasture template. These comparisons are applicable, since the same measurement parameters will be calculated for each system.

D.5.2 Reference Sites

Restored area comparisons to reference sites will also be conducted. To accomplish this, a series of reference sites have been established and characterized using similar measurement parameters. The reference sites for FCP ecological restoration include the following:

- Riparian forest
- Wet forest
- Upland forest complex
- Emergent wetland/open water area
- Wet prairie
- Upland prairie.

Section 3.2 of the 2002 Consolidated Monitoring Report briefly describes each of the sites above. Unlike the baseline conditions, reference sites and restored areas will be compared on a system-specific bases. Using the example from above, the emergent wetland component of the restored area will be compared to the emergent wetland reference site, while the wet prairie component of the restoration project is compared to the wet prairie reference site.

D.5.3 Project Comparisons

As described above, the restored systems will be compared to both baseline conditions and appropriate reference sites. The Consolidated Monitoring Report will present the restored area data against its corresponding baseline and reference site data. Detailed data analysis and interpretation will be the responsibility of the NRTs. An approach to quantify progress was presented in the 2001 Consolidated Monitoring Report. The NRTs can use this approach or some other methodology to evaluate success, if so desired.

D.6 SCHEDULE

The schedule for Functional Phase monitoring is set up to evaluate a single type of system on an annual rotation. In other words, all wetland restoration projects will be evaluated in year one, all prairies and savannas in year two, and all forest systems in year three. This rotation will be repeated at least once, starting in 2003. Baseline and reference sites have been characterized in 2001 and 2002.